# A Multiwavelength Autopsy of the Interacting Supernova 2020ywx

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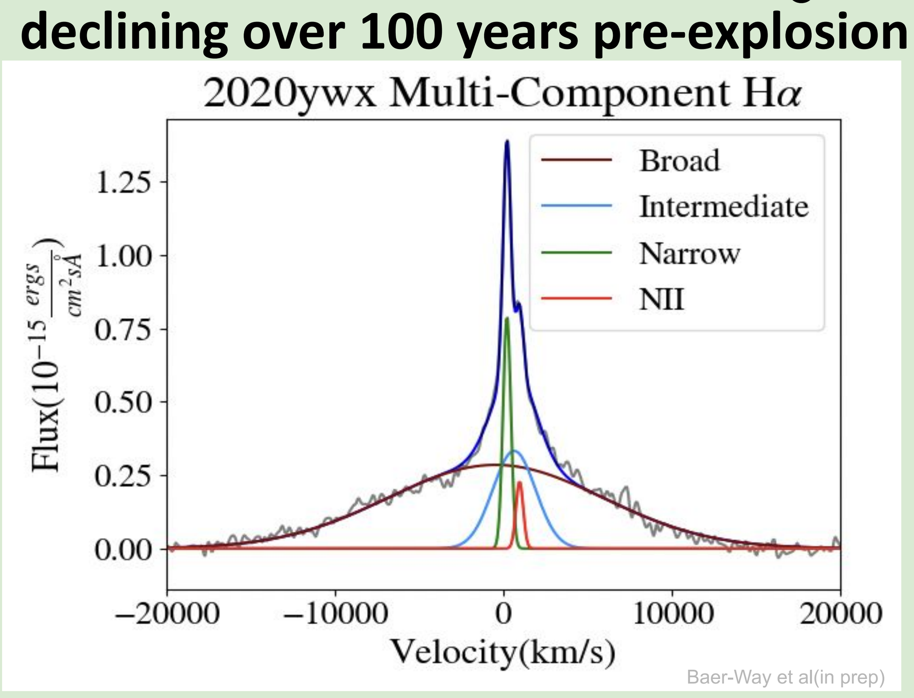
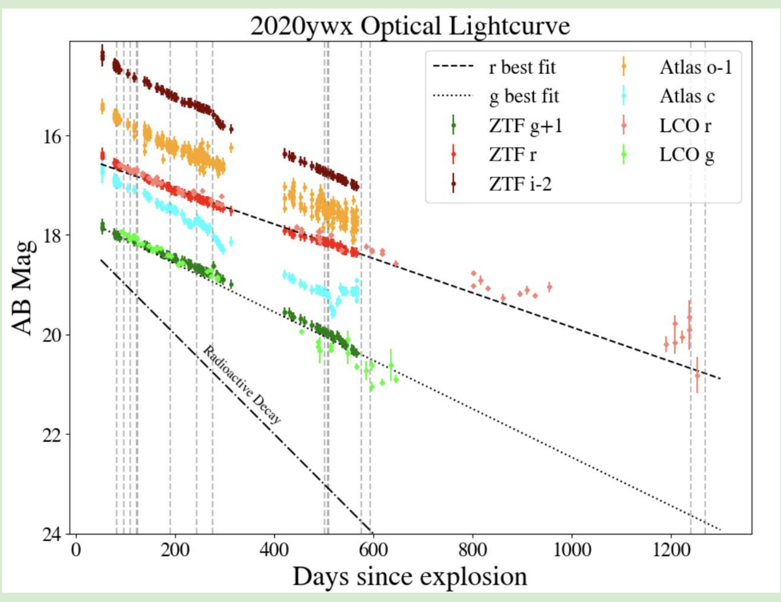
## Introduction

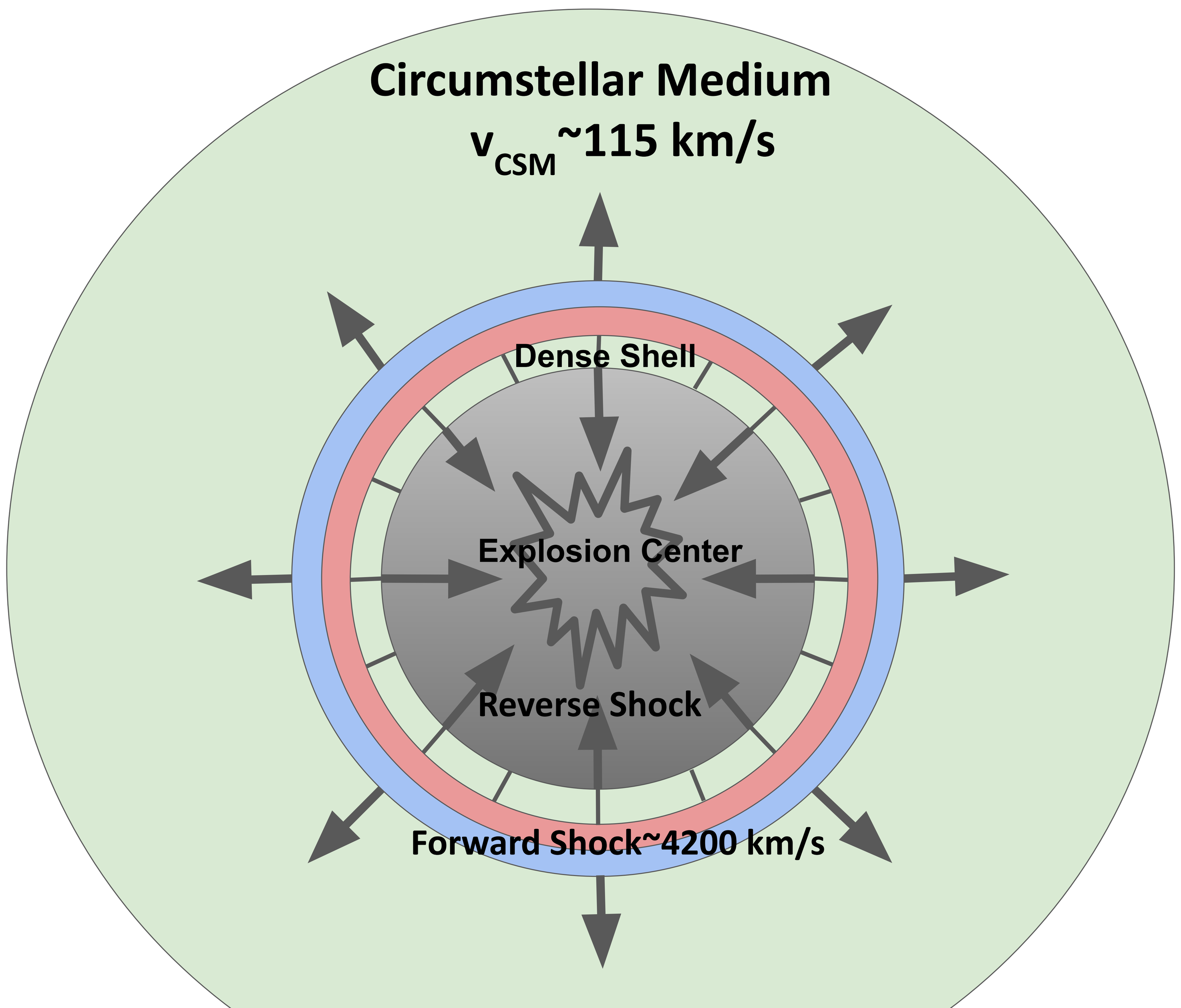
- While **interacting supernovae** (defined by extensive interaction between the supernova ejecta and dense pre-existing circumstellar material) are being discovered at increasing rates across the electromagnetic spectrum, their **progenitor channels are still relatively unconstrained**
- **Combining evidence across wavelengths** is a robust way to constrain possible progenitor mechanisms
- We seek to do this for SN 2020ywx-a **type IIn supernova** at 96 Mpc which showed **signatures of strong interaction** from the earliest observations
- Through **radio** (GMRT+VLA), **optical/NIR** photometric+spectroscopic (ZTF+MMT+Magellan+Keck+LCO) and **X-ray** (Swift+Chandra) observations, we **constrain the mass-loss rate across wavelengths/time** and different components of interaction

## Optical/IR

- SN 2020ywx is similar to other SNe IIn in the optical-**multi-component line emission** from ejecta+shell between forward and reverse shock+unshocked CSM
- The **intermediate-width line emission is blueshifted over time**-suggests presence of dust in dense shell
- IR spectra indicate rising continuum suggestive of **dust blackbody emission**
- Absorption component of IR Helium P cygni gives **115 km/s CSM/wind speed**-constant over time
- Optical lightcurve quite flat-suggestive of a CSM created by **uniform mass-loss**
- Hα Luminosity/shock+wind speed constrains **mass-loss rate~0.01 $M_\odot yr^{-1}$-declining over 100 years pre-explosion**

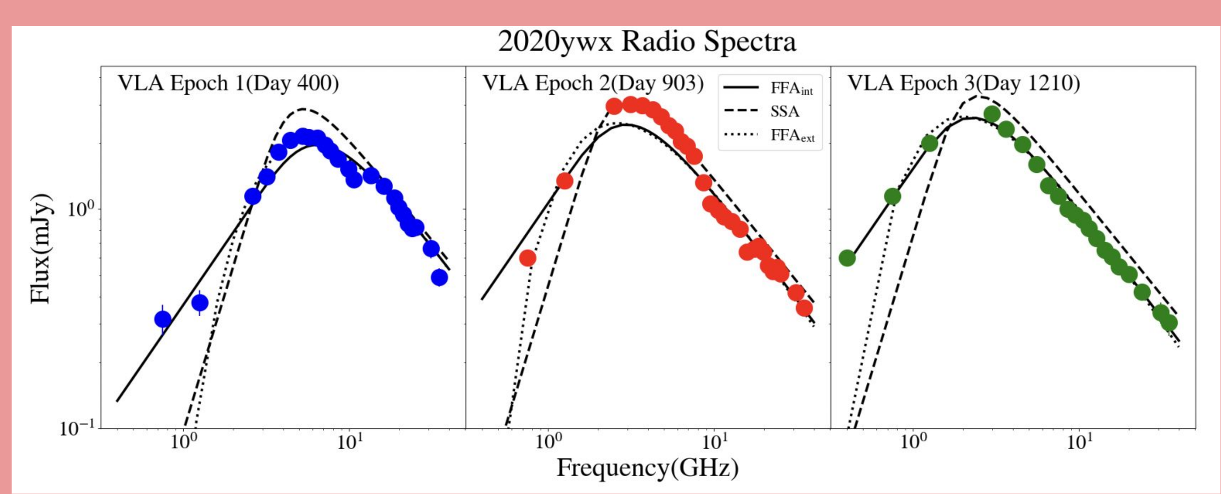


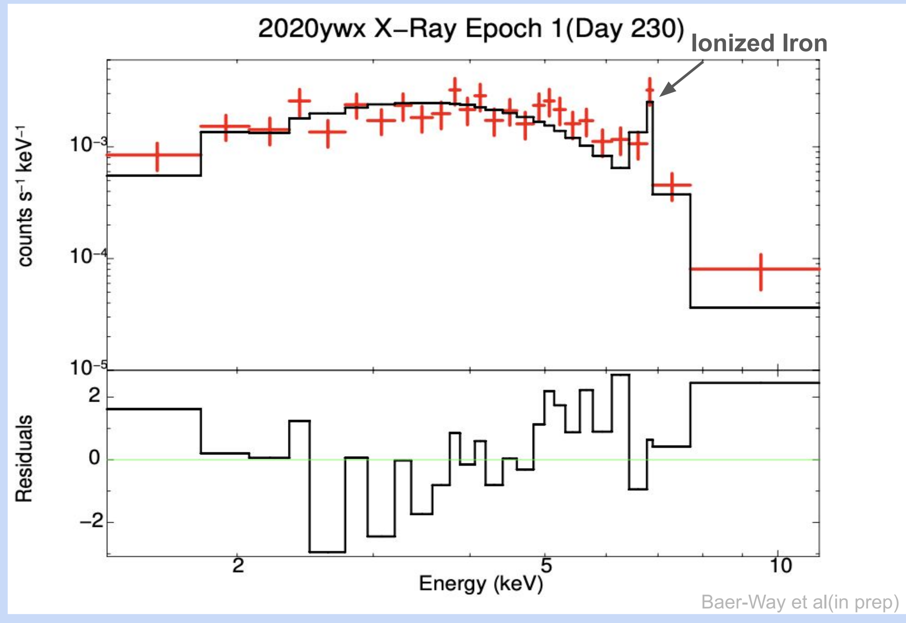

## Radio

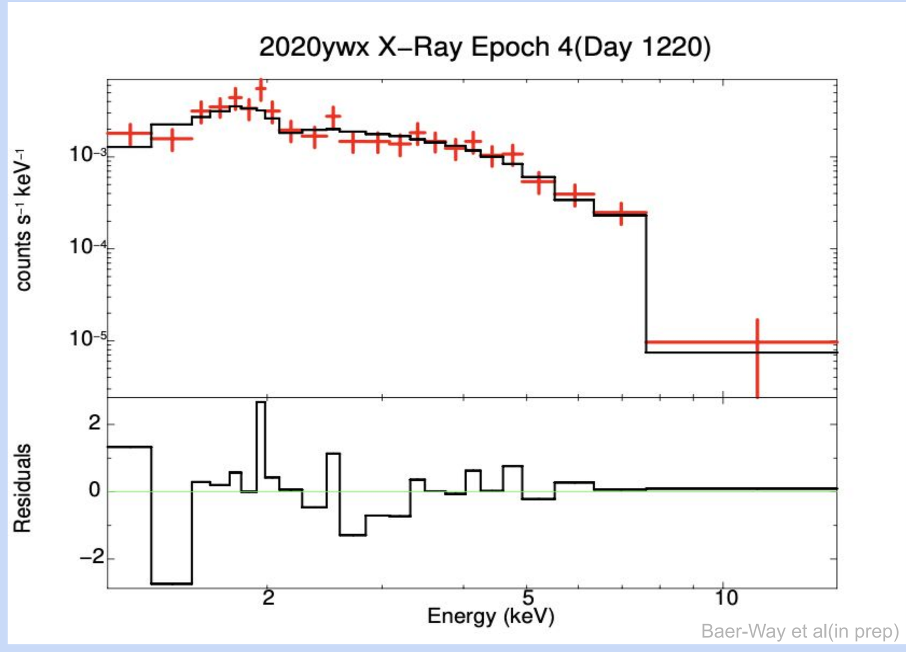
- Combined VLA+GMRT wideband(0.4-40 GHz) radio spectra at 3 epochs
- Radio emission **best fit ($X_v^2$=1.3) by Internal Free-Free Absorption(FFA)** vs Synchrotron Self-Absorption(SSA) model-suggestive of dense medium
- Preferred absorption mechanism gives optical depth to **constrain the mass-loss rate→0.01 $M_\odot yr^{-1}$-declines over 100 years pre-explosion** assuming decreasing CSM Temperature




## X-Rays

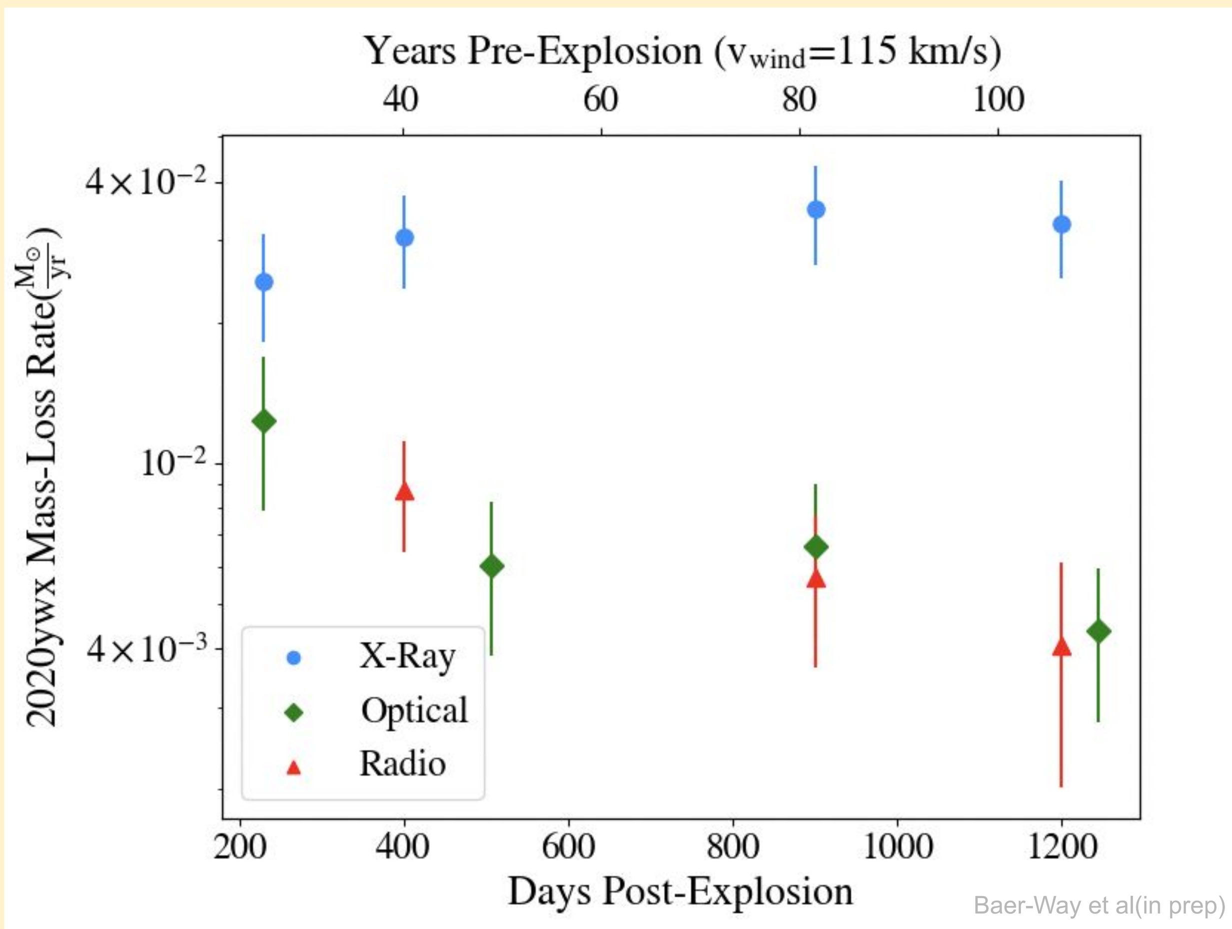
- In the X-rays, SN 2020ywx is highly luminous-**2nd most luminous X-ray SNe IIn of all time**-peaking at 7x10[41] ergs/s
- X-ray emission is coming from the **adiabatic forward shock** based on temperature/calculations of cooling times in forward and reverse shock
- Find **shock speed from best-fit temperatures**
- Derive mass-loss rate from consideration of adiabatic forward shock
- Find relatively **constant mass-loss rate of 0.02 $M_\odot yr^{-1}$**
- Potential clumps/asymmetries or contribution from reverse shock at late times causing **mass-loss rate plateau**




## What was SN 2020ywx's progenitor?

- All 3 measurements of the mass-loss rate are consistently high +relatively steady over time
- Discrepancies between wavelengths point to **asymmetries/ complex X-ray Emission**
- **Scale ($10^{-2}$ $M_\odot yr^{-1}$)+duration (>100 years) of mass-loss+CSM speed (115 km/s) rule out the following progenitor mechanisms:**
  - **-Shells of CSM created by LBV-**mass-loss occurs for too long+too uniform
  - **-Pulsational pair instabilities/wave-driven instabilities-**mass-loss occurs for too long/too H-rich/CSM speed too low
- **Binary interaction seems to be the only possibility that could explain all the observables**
- **Baer-Way et al in prep!**

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